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Thomas et al.

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[54] **WINDER AND METHOD FOR THE CONTINUOUS WINDING OF A MATERIAL WEB**

[75] Inventors: **Roland Thomas**, Heidenheim; **Ralf Preising**, Holzkirch; **Roland Moeller**, Herbrechtingen, all of Germany

[73] Assignee: **Voith Sulzer Papiermaschinen GmbH**, Germany

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[52] **U.S. Cl.** **242/541.1**; 242/541.6; 242/542.3

[58] **Field of Search** 242/541.1, 541.4, 242/541.5, 541.6, 541.7, 547, 542.3

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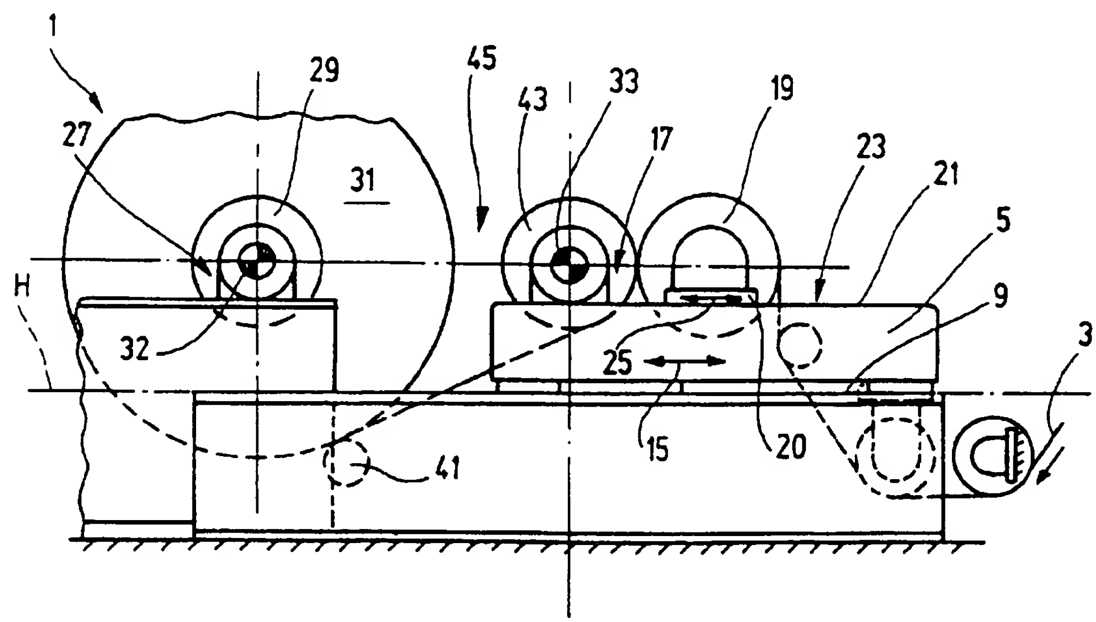
Primary Examiner—John M. Jillions
Attorney, Agent, or Firm—Ostrolenk, Faber, Gerb & Soffen, LLP

[57] **ABSTRACT**

A winder for continuous winding of a material web, like a paper or board web, on a winding spool to form a wound reel. A contact pressure drum is rotatably supported on a displaceable transport device and the drum itself is displaceable with respect to the transport device to form a widening nip with the wound reel. The transport device also supports a primary bearing for holding an empty spool during the start of the winding process. The bearing for the empty spool is between the contact pressure drum and a secondary bearing for supporting the wound reel in the final winding position. The primary bearing for the initially empty spool is fixed in location on a transport device. The transport device is in turn transportable toward and away from the secondary bearing for the wound reel. The contact pressure drum is supported to move along with the transport device as well as also being displaceable with respect to the transport device to maintain the line pressure during increase in the wound spool diameter.

32 Claims, 3 Drawing Sheets



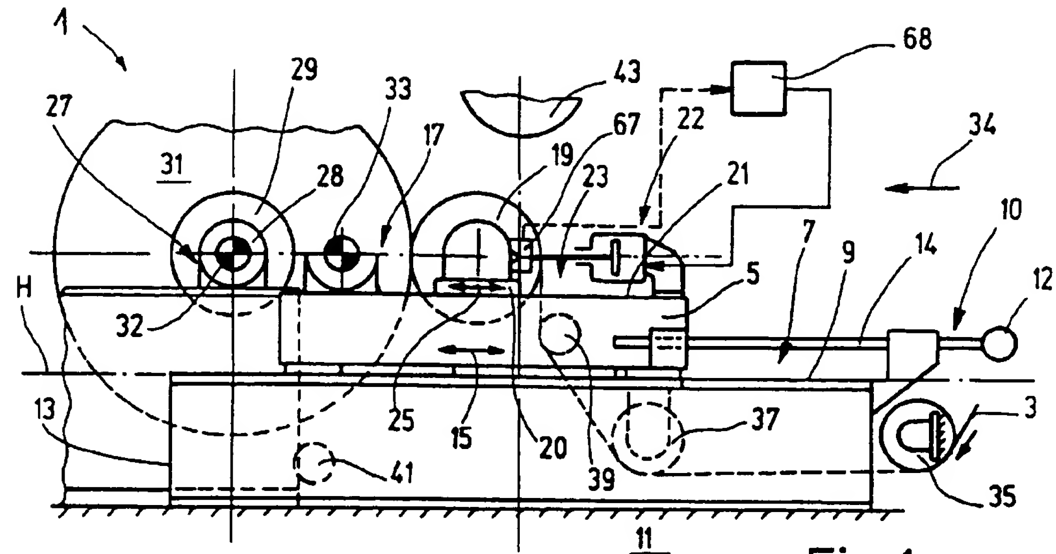


Fig. 1

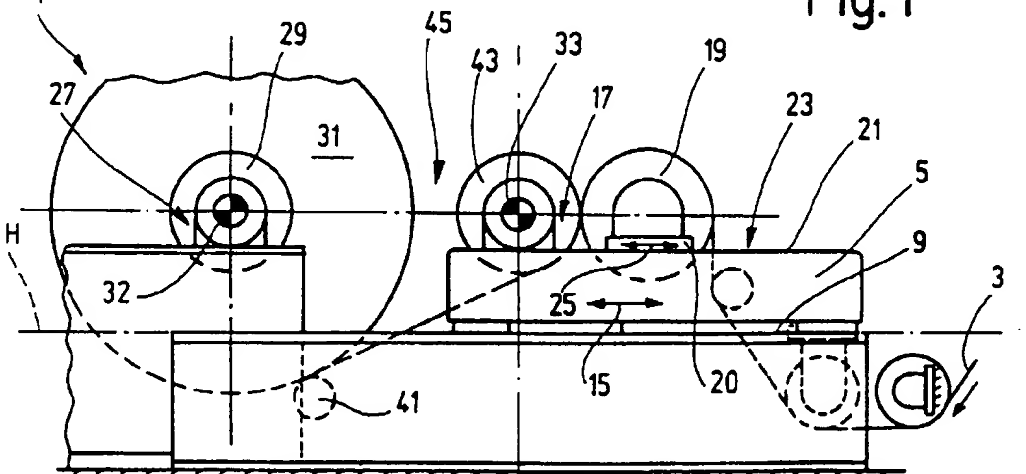


Fig. 2

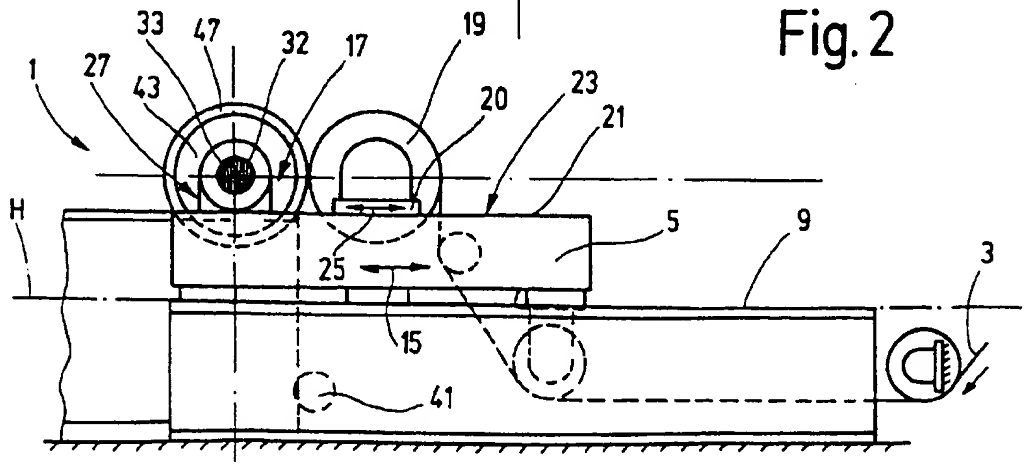


Fig. 3

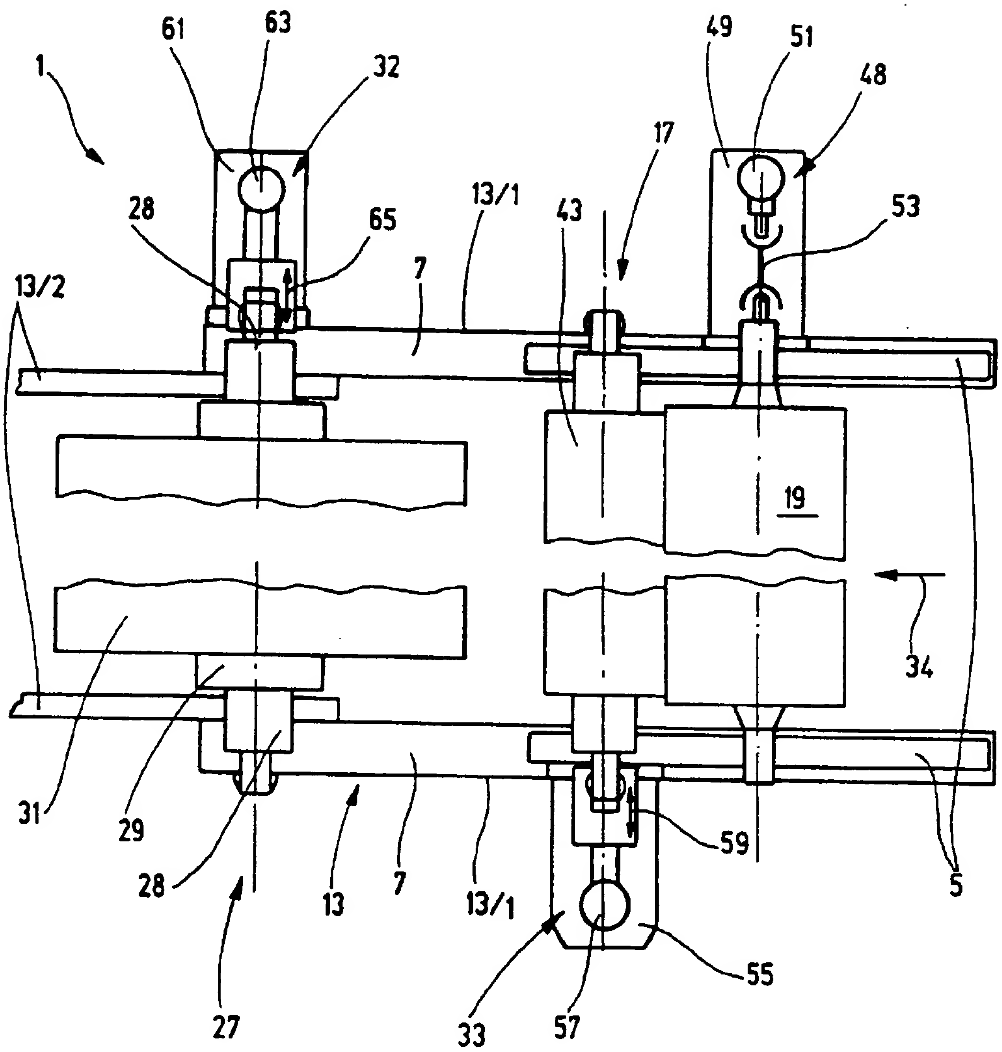

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Fig. 4

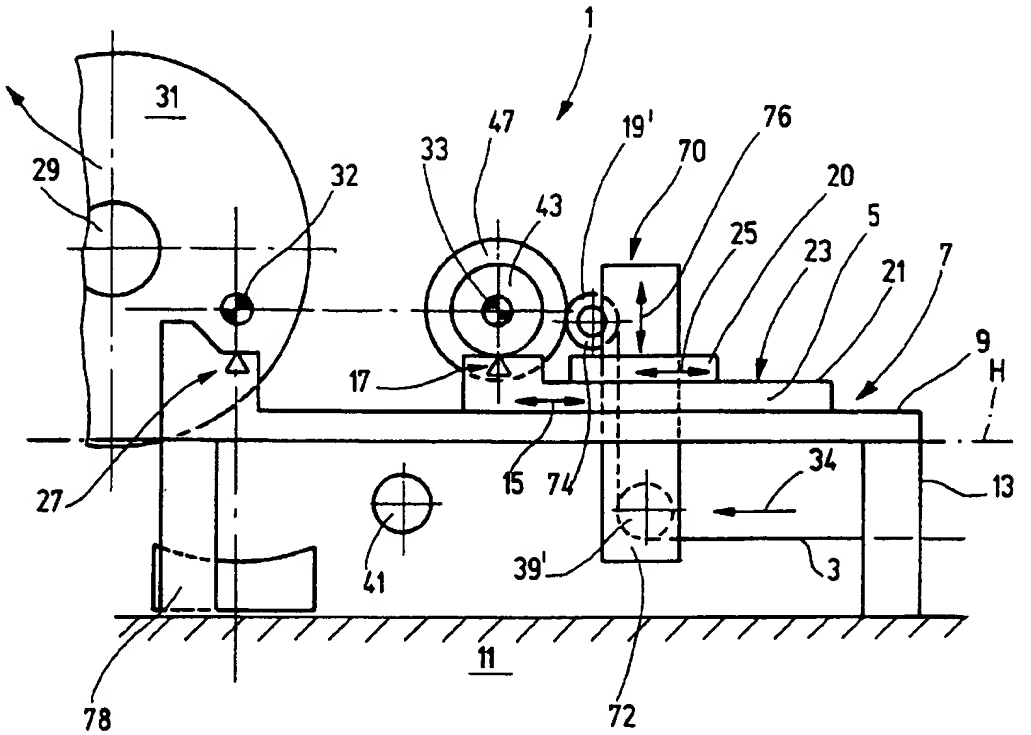
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Fig. 5

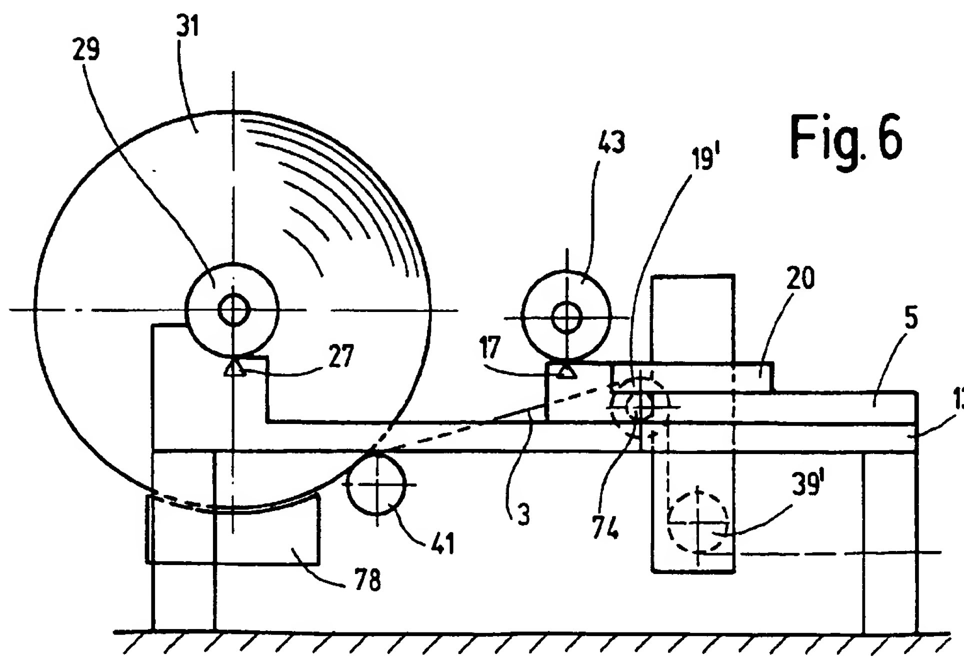
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Fig. 6

WINDER AND METHOD FOR THE CONTINUOUS WINDING OF A MATERIAL WEB

BACKGROUND OF THE INVENTION

The present invention relates to a winder for continuously winding a material web, especially a paper or board web, and to a method for continuously winding a web.

Winders and methods of the type addressed here are known from DE 196 07 349, which is equivalent to U.S. application Ser. No. 08/807,485. The known winder comprises a contact pressure drum that is displaced by a pressure-applying device, to press the drum in a defined manner against the circumference of a wound reel and form a winding nip with the reel. The contact pressure drum is arranged on a first transport device that can be moved on a guide. The spool on which the wound reel is wound is rotatably held by a primary bearing as the winding process begins. The primary bearing can be translated with respect to the first transport device for the contact pressure drum with the aid of an additional second transport device.

The winding machine further comprises a secondary stationary bearing, which holds the spool to rotate at a fixed position during the final winding process.

At a spool change, an empty spool is introduced into the primary bearing, the material web is severed and its free end is wound onto the empty spool. During start of the winding, while the spool is being held by the primary bearing, the increasing wound reel diameter is compensated for or set by displacing the first transport device and controlling the line force in the winding nip between the contact pressure drum and the wound reel by relative movement of the contact pressure drum with respect to the first transport device. After it reaches a desired wound reel diameter, the wound reel is transferred into the secondary bearing where it is finally wound.

Known winders are relatively complicated to construct and are thus of high cost. This is particularly caused by the second transport device that bears the primary bearing, because an additional control unit is necessary for controlling its displacement. When the wound reel is transferred into the secondary bearing, it is difficult to control the movement of the two transport devices synchronously such that at the same time the control of the line force is able to maintain the desired line force. Instead, there is the risk of a step change in the line force.

DE 44 15 324 A1 which corresponds to U.S. Pat. No. 5,577,685 discloses a winder which has a first, horizontally movable transport device, to which a vertically movable second transport device is fitted. A contact pressure drum, which forms a winding nip with a wound reel, is rotatably supported on the second transport device. The drum can be moved backward and forward relative to the second transport device by a pressure applying device, in order to set the line force in the winding nip. A third transport device is also provided for transferring an empty spool from a ready position into the winding start position, which is located at a lower level. At a spool change, the contact pressure drum is first moved vertically upward into a transfer position. There the contact pressure drum forms a winding nip with an empty spool that is rotatably held on the third transport device. The material web is now severed and its free end is wound onto the empty spool. The spool is subsequently transferred, together with the contact pressure drum, into the winding start position located at a lower level. To this end, the second and the third transport devices are moved vertically downward. During the start of winding and the transfer into the winding start position, the new spool, together with the wound reel wound thereon which has only a few wound layers, is driven by means of a primary drive. From the winding start position, the wound reel is moved horizontally into a final winding position, in which the primary drive is uncoupled and a secondary drive is coupled to the wound reel. The secondary drive drives the wound reel during the further winding process. This winder has a relatively complicated construction, particularly because the second and third transport devices are displaceable independently of each other. Furthermore, control over the displacements of the three transport devices is very complicated.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a winder and a method of its operation without the foregoing disadvantages. In particular, the wound-on new spool should be displaceable into the stationary secondary bearing in a way which allows maintenance of a desired line force in the winding nip with the least possible effort during the displacement.

In order to achieve this object, a winder for continuous winding of a material web, like a paper or board web, on a winding spool to form a wound reel has a contact pressure drum which is rotatably supported on a displaceable transport device and the drum itself is displaceable with respect to the transport device to form a winding nip with the wound reel. The transport device also supports a primary bearing for holding an empty spool during the start of the winding process. The primary bearing for the empty spool is between the contact pressure drum and a secondary bearing for supporting the wound reel in the final winding position. The primary bearing for the initially empty spool is fixed in location on the transport device. The transport device is in turn transportable toward and away from the secondary bearing for the wound reel. The contact pressure drum is supported to move along with the transport device as well as also being displaceable with respect to the transport device to maintain the line pressure during increase in the wound spool diameter.

The winder has a primary bearing that is arranged in a fixed location on the transport device. Here, "fixed location" is provided by a bearing which holds the spool so that it can rotate and which prevents translational displacement of the spool on the transport device. The primary bearing and the contact pressure drum therefore have a single, common transport device. As a result, structure of the winder and its control can be simplified.

A preferred exemplary embodiment of the winder is distinguished in that while the wound reel is being held by the secondary bearing as it is being finally wound, the increasing wound reel diameter is compensated for by a thrust device that displaces the transport device carrying the contact pressure drum. At the same time, the line force in the winding nip is controlled/regulated by relative movement of the contact pressure drum with respect to the transport device. A controller/regulator is provided for this purpose. It interacts with the pressure-applying device by which the contact pressure drum can be displaced. The displacement of the contact pressure drum relative to the transport device sets the pressure forces in the winding nip between the contact pressure drum and the wound reel. The contact pressure drum has a significantly lower weight than the wound reel, which becomes heavier with increasing diameter, so that rapid compensation of fluctuations and

jumps of the line force or of the line force profile occurring in the winding nip is enabled. As a result, the line force can be set extremely finely, which enables a high winding quality to be achieved.

The above-described control or regulation of the line force begins directly at a spool change and remains continuously effective, not only during the winding start process, but also during the common transfer of the new wound spool and the contact pressure drum toward the secondary bearing and during the following final winding process. The significant advantage of the invention arises from the control/regulation of the line force during the winding start process and during transfer of the wound spool into the secondary bearing being performed in a simple and precise manner by simply displacing the contact pressure drum by the pressure-applying device relative to the transport device. Automatic maintenance of the desired line force during the various steps is thus enabled without difficulty and without additional outlay. Only during the final winding process is the maximum stroke of the pressure-applying device generally insufficient to follow the increasing wound reel diameter. Then the thrust device, which is necessary in any case to displace the transport device, draws the transport device, including the contact pressure drum, the pressure-applying device and the now empty primary bearing, gradually away from the secondary bearing, corresponding to the increase in the wound reel diameter.

In an advantageous embodiment of the winder, the primary bearing has a primary drive, preferably a center drive, for the wound reel. This drive applies a defined torque to the spool held by the primary bearing. The primary drive is preferably arranged in a stationary manner in a fixed location on the transport device. This enables the construction of the winder to be further simplified, since additional guide and transport devices are not needed for the primary drive. It is also possible to arrange the primary drive on a separate transport device and, when transferring the wound reel that is rotatably held by the primary bearing to the secondary bearing, to displace the primary drive at the same time parallel to the primary bearing. This arrangement enables torque to be applied to the spool during the entire winding process. As a result, in interaction with the above described control or regulation of the line force in the winding nip, a wound reel having a defined, preferably uniform winding hardness profile can be produced.

In a method for continuously winding a material web, the material web is first led over a circumferential region of a contact pressure drum, which forms a winding nip with the wound reel. In order to prepare a spool change, a free draw of the material web is formed between the contact pressure drum and the almost finished wound reel. An empty new spool is introduced into the region of the free draw in a winding start position. A winding nip is then formed between the contact pressure drum and the empty spool by displacing the contact pressure drum with respect to a transport device which supports the contact pressure drum and the empty new spool. The material web is then severed and its free end is wound onto the new spool which at that time is located in its winding start position, with the control/regulation of the line force in the winding nip beginning immediately. To this end, the contact pressure drum is displaced in a defined way relative to the transport device. After a desired wound reel diameter is achieved, which in the case of a preferred embodiment is only slightly larger than the diameter of the empty spool, the wound reel is transferred into a final winding position, at which the wound reel is rotatably held in a stationary manner during the final winding process. During that transfer, control/regulation of the line force is continued without interruption. In addition, while the wound reel is now located in its final winding position, the line force in the winding nip is further controlled/regulated by relative movement of the contact pressure drum with respect to the transport device carrying the contact pressure drum. At the same time, the increasing wound reel diameter is preferably compensated for by relative movement of the transport device with respect to a base, for example, a foundation, on which the winder stands.

The method described above achieves a desired hardness of the wound reel and hence a very good winding quality uniformly throughout the entire winding process. Furthermore, advantageously, as a result of displacing the contact pressure drum on the common transport device in order to control/regulate the line force in the winding nip, the increasing wound reel diameter is compensated for during the entire winding start process, including the transfer into the final winding position. The outlay for controlling the displacement movements of the contact pressure drum, wound reel and transport device during the entire winding process is therefore relatively low.

Other features and advantages of the present invention will become apparent from the following description of the invention which refers to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1 to 3 each schematically show the principle of an embodiment of a winder in various winding phases;

FIG. 4 shows a schematic plan view of the winder of FIGS. 1 to 3 and

FIGS. 5 and 6 each schematically show the principle of a further embodiment of the winder.

DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

A winder of the invention described below can generally be used for winding a material web. The winder may be arranged at the outlet end of a machine for producing or finishing a material web, for example a paper web, for winding up the finished material web to form a wound reel. However, the winder may also be used to rewind an already wound coil, also referred to as a wound reel.

FIGS. 1 to 3 each show a side view of an exemplary embodiment of a winder 1, which is used for winding a material web 3, for example a paper web, onto a spool. The spool can be formed, for example, from a tubular roll. FIGS. 1 to 3 disclose a sequence of functional steps of the winder 1.

The winder 1 includes a transport device 5, also referred to as a carriage, which is movable along a first guide 9 comprised of guide rails 7. The side view of FIGS. 1 to 3 shows only one of the guide rails 7. The guide rails 7 are fastened to a winder frame 13 supported on a foundation 11, and the rails are aligned parallel to an imaginary horizontal H in dash-dot line. A thrust device 10 illustrated in FIG. 1, moves the transport device 5 on the first guide 9 to displace the transport device 5 in the horizontal direction (double arrow 15). The thrust device 10 is fitted to the winder frame 13. The device 10 comprises a spindle drive, which comprises a threaded spindle 14 that is driven by a motor 12. It is also possible, for example, for a hydraulic piston/cylinder unit to be used as the thrust device.

A primary bearing 17, which is illustrated schematically, is arranged on the transport device 5 in a fixed location. The

bearing **17** is used for holding or for supporting a spool for rotating during the winding start process. The primary bearing **17** therefore has a fixed position on the movable transport device **5**. The "winding start process" refers to the phase of the winding process in which a spool is held by the primary bearing **17**.

A contact pressure drum **19**, also referred to as a supporting roll, is held rotatably on a guide carriage **20**. That carriage is movable on a guide **23** comprised of rails **21**, of which only one rail **21** can be seen. The rails **21** are fastened to the transport device **5** and preferably extend parallel, or at least substantially parallel, to the guide rails **7** of the first guide **9**. The guide carriage **20** can be moved along the rails **21** (shown by double arrow **25**) by a pressure-applying device **22** that is fastened on the transport device **5**. The pressure-applying device **22** is a preferably hydraulic, piston/cylinder unit, which comprises a piston guided in a cylinder. A piston rod is fastened to the piston. The other end of the piston rod is connected to the guide carriage **20** or, respectively, the bearing of the contact pressure drum **19** which is fastened to that carriage. The configuration of the pressure-applying device **22** is variable, so that in a different exemplary embodiment, the pressure-applying device **22** can be formed, for example, by a spindle drive. The contact pressure drum **19** may have an adjustable drive torque applied to it, by a center drive that is not illustrated in FIGS. **1** to **3**, but which is arranged in a stationary fashion on the transport device **5**.

A stationary secondary bearing **27** is fastened to the winder frame **13**. The secondary bearing **27** rotationally holds and guides a spool having a bearing journal **28**, during the final winding process. In the winding phase illustrated in FIG. **1**, the continuously incoming material web **3** is wound onto a spool **29** held by the secondary bearing **27** in order to form a wound reel **31**. "Final winding process" refers to that part of the winding process during which the wound reel is held by the secondary bearing **27**. The secondary bearing **27** has a secondary drive **32**, which is indicated by a symbol, and which drives the spool that is held by the secondary bearing **27**. The secondary drive **32** is a center drive, which is fastened to the winder frame **13** and therefore has a fixed position within the winder **1**.

In addition, the primary bearing **17** has a primary drive **33**, also indicated by a symbol, which applies a defined torque to the respective spool held by the primary bearing **17**. In the winder embodiment in FIGS. **1** to **3**, the primary drive **33** is arranged stationary on the transport device **5** and is displaced with the transport device **5**. This means that no additional guide is needed for the primary drive **33**. Therefore, the structure of the winder and its control can be simplified. In a different embodiment, the primary drive **33** is displaceable parallel to the rails **21** of the second guide **23**, irrespective of the displacement movement of the transport device **5**.

FIG. **1** shows the material web **3** guided from the production or processing machine (not shown) arranged upstream of the winder **1**, as viewed in the running direction of the material web **3** (arrow **34**), first over a turn roll **35** arranged in a fixed location, and then over a turn roll **37** which is rotatably mounted on the transport device **5**. The web **3** is next guided over a third turn roll **39**, which is arranged underneath the contact pressure drum **19** and is illustrated with dashed lines, to the contact pressure drum **19**. The turn roll **39** is preferably constructed as a web stretch roll.

The material web **3** is guided over a circumferential region of the contact pressure drum **19** of about 180° and is wound onto the wound reel **31** which is held by the secondary bearing **27**. The contact pressure drum **19** is pressed against the circumference of the wound reel **31** with a defined force forming a winding nip through which the material web **3** is guided. The line force, also referred to as clamping pressure or clamping force, in the winding nip is controlled by displacing the contact pressure drum **19** on the second guide **23** in the directions of the double arrow **25**. In a different embodiment of the winder, the line force in the winding nip may be regulated automatically to a desired value with the aid of a regulator. In both cases, the pressure-applying device **22**, which cooperates with the guide carriage **20** carrying the contact pressure drum **19**, is influenced in a defined manner. For example, in FIG. **1** a measuring device **67** and a control or regulating unit **68** are indicated schematically. By displacing the contact pressure drum **19**, fluctuations in the line force can be compensated for or avoided, achieving a continuously desired winding hardness. The increasing diameter of the wound reel **31**, while the wound reel **31** is held by the secondary bearing **27**, is compensated for by displacing the transport device **5** and with it the contact pressure drum **19** in the direction opposite to the web running direction (arrow **34**), to the right in the illustrated embodiment.

A pinch roll **41** or pressure roll is arranged underneath the wound reel **31** that is held by the secondary bearing **27** and extends over the entire width of the wound reel **31**. The roll **41** can be displaced by a guide device, not illustrated, to be pressed against the circumference of the wound reel **31** that forms a winding nip with the contact pressure drum **19**. (Compare FIGS. **1** and **2**.) The pinch roll **41** prevents air from being dragged between the winding layers of the wound reel **31**, for example when the material web **3** is being guided in a free draw. The pressure exerted by the pinch roll **41** against the circumference of the wound reel **31** is adjustable. The pinch roll **41** may be driven by a drive, for example a center drive, preferably before and at least while the pinch roll **41** is pressed against the circumference of the wound reel **31** on the bearing **27**.

The operation of the winder **1** is explained below with reference to a winding process. The material web **3** is guided over the contact pressure drum **19** and is wound onto the wound reel **31** that is held by the secondary bearing **27** (FIG. **1**). Before the wound reel **31** has attained its final/intended diameter, the pinch roll **41** is pressed against the circumference of the wound reel **31** (FIG. **2**). This guides the material web **3** both through the winding nip between the contact pressure drum **19** and the wound reel **31**, and through the winding nip between the pinch roll **41** and the wound reel **31**.

To transfer the continuous material web **3** onto an empty spool **43** that is arranged in a ready position above the contact pressure drum **19** (FIG. **1**), the contact pressure drum **19** is moved to the right by the transport device **5** along the rails **21** of the second guide **23**, in a direction opposite to the running direction of the material web **3** (arrow **34**) and also preferably at high speed. This increases the distances between the contact pressure drum **19** and the wound reel **31** creating a space **45** (FIG. **2**). In the region of the space **45**, the material web **3** is transferred in a free draw from the contact pressure drum **19** onto the wound reel **31**. During the spool change, the pinch roll **41** is pressed against the circumference of the wound reel **31** with a defined force. This both prevents the dragging of air between the winding layers of the wound reel **31** and assures that an exact hardness of the winding layers wound onto the wound reel **31** can be achieved.

Next, the empty spool **43** is introduced from above into the interspace **45** between the contact pressure drum **19** and the wound reel **31**. Before the spool **43** is moved against the material web **3**, which is being guided in a free draw, the spool is accelerated to the running speed of the material web **3** by a throw-on device, not illustrated. Movement of the empty spool **43** into the free web draw deflects the material web **3** and guides the web over a circumferential region of the spool **43**. The spool **43** is introduced directly into the primary bearing **17**, which is arranged in a transfer position, and the new spool is rotatably held by the primary bearing **17** (FIG. **2**). The empty spool **43** is then rotationally fixedly connected to the primary drive **33**. By displacing the contact pressure drum **19** against the spool **43**, a nip or winding nip is formed between the drum **19** and the empty spool **43**. The material web **3** is then severed at the free draw between the spool **43** and the roll **41** by a severing device, for example, a known high pressure blast device, not illustrated, and the free end of the web is wound onto the empty spool **43**. While the spool **43** is held by the primary bearing **17**, the increasing diameter of the wound reel **47** that is wound on the spool **43** (FIG. **3**), and the line force in the winding nip between the wound reel and the contact pressure drum **19** is compensated for or controlled/regulated by displacing the contact pressure drum **19**. The control/regulation of the line force to set a desired value also automatically compensates for the increasing wound reel diameter by defined displacement of the contact pressure drum **19** relative to the primary bearing **17** that is arranged in a fixed location on the transport device **5**.

As seen from FIG. **3**, to transfer the wound reel **47** from the winding start position and at the primary bearing **17** into the final winding position, to the secondary bearing **27**, the transport device **5** is moved in the web running direction (arrow **34**). In the operational position of the winder illustrated in FIG. **3**, the wound reel **47** is transferred from the primary bearing **17** to the secondary bearing **27**. The secondary drive **32** is now coupled to the spool **43**, on which the wound reel **47** is being wound, so that both drives **32** and **33** are briefly effectively connected to the spool **43**. Finally, the primary drive **33** of the primary bearing **17** is detached from the spool **43** and may be moved into its transfer position (FIG. **1**).

The duration of the winding start process, that is, the period when a wound reel is guided by the primary bearing **17**, is variable. It can be a very short time, for example, so that the wound reel has an only relatively low diameter growth. As a result, the maximum stroke of the piston of the pressure-applying device **22** can be kept small. In a preferred embodiment, the maximum stroke of the piston is less than half the material layer thickness of a finished wound reel. It is preferable if the transport device **5** is at a standstill during the introduction of an empty spool into the primary bearing and during an adjustable period after the free end of the material web has been wound onto the empty spool.

The method of operation readily emerges from the description of FIGS. **1** to **3**. It comprises the following. To prepare for a spool change, a free draw of the material web is formed between the contact pressure drum and the almost finished wound reel. Next, an empty spool is moved into a winding start position in the region of the free draw. Afterward, the contact pressure drum is relatively moved with respect to a transport device carrying the spool, and the drum is pressed against the circumference of the empty spool, forming a winding nip. The material web is then severed and its free end is wound onto the empty spool. To compensate for the increasing wound reel diameter, while the spool is located in the winding start position, the line force in the winding nip is controlled/regulated. For this purpose, the contact pressure drum is displaced. Then, the winding reel is transferred from the winding start position into the final winding position and continues to be wound here until winding is finished. During these processes, the control/regulation of the line force in the winding nip, by relatively moving the contact pressure drum with respect to the transport device carrying the contact pressure drum, is continued without interruption. The increasing wound reel diameter of the wound reel which is located in the final winding position is now preferably additionally compensated for by relative movement of the entire transport device **5** with respect to a base, the foundation **11**. This enables the maximum piston stroke of the pressure-applying device **22**, as already mentioned above, to be kept relatively small.

FIG. **4** is a schematic plan view of the winder **1** of FIGS. **1** to **3**. Identical parts are provided with the same reference symbols. The functional position in FIG. **4** corresponds to FIG. **2**. The winder frame **13** has an outer part **13/1** and an inner part **13/2**. The guide rails **7** of the first guide **9** are fastened on the outer part **13/1** of the winder frame **13**.

A center drive **48** for the contact pressure drum **19** is arranged on the drive side of the winder **1** for applying torque to the rotationally mounted contact pressure drum **19**. The center drive **48** is fitted to a bracket **49** fastened to the transport device **5**. It comprises a motor **51** and an articulated shaft **53**, which is connected to a bearing journal of the contact pressure drum **19**. The articulated shaft **53** enables the contact pressure drum **19** on the guide rails **7** to move relative to the transport device **5** and thus to move relative to the motor **51** that is arranged on the device **5** in a fixed location, without the drive train having to be interrupted, so that the articulated shaft **53** should be separated from the contact pressure drum or the motor. The contact pressure drum **19** therefore has a torque permanently applied to it.

Furthermore, a bracket **55** is fastened to the transport device **5** on the front side of the winder **1** for carrying the primary drive **33** of the primary bearing **17**. The primary drive **33** comprises a motor **57** which, as a double arrow **59** indicates, can be coupled to a replacement spool **43** guided by the primary bearing **17**.

A bracket **61** which supports the secondary drive **32** is fastened to the outer part **13/1** of the winder frame **13** on the drive side of the winder **1**. The secondary drive **32** comprises a motor **63** which double arrow **65** indicates can be coupled to the spool **29** held by the secondary bearing **27**.

Arranging the primary drive **33** and the secondary drive **32** on opposite sides of the winder **1**, i.e. the front side and drive side, respectively, enables a spool to have a torque applied to it during the entire winding process. This is explained below with reference to the transfer of the spool **43** from the winding start position into the final winding position.

Before the spool **43** that is being guided by the primary bearing **17** is transferred into the final winding position, the secondary drive **32** is separated from the spool **29** on which the finished wound reel **31** is being wound. The wound reel **31** is moved out of the secondary bearing **27**, so that the spool **43** that is being held by the primary bearing **17** and driven by the primary drive **33** can be picked up. The spool **43** is transferred from the winding start position illustrated in FIG. **4** into the final winding position by displacing the transport device **5** in the direction of the arrow **34**. Transfer of the spool **43** from the primary bearing **17** to the secondary bearing **27** then takes place. The secondary drive **32** is then

coupled to the spool **43**. This produces the operational position of the winder **1** illustrated in FIG. 3, in which both the primary drive **33** and the secondary drive **32** are simultaneously coupled and are effectively connected to the spool **43**. After the secondary drive **32** has taken over the drive function for the spool **43**, the primary drive **33** is uncoupled from the spool **43**. The transport device **5** moves the primary drive back into the transfer position, in which a new empty spool can be taken over by the primary bearing **17**.

FIGS. **5** and **6** are schematic side views of a second embodiment of the winder **1**. Parts corresponding to those described in the preceding Figures are provided with the same reference symbols, so that reference can be made to the description relating to FIGS. **1** to **4**. Only the differences are discussed below.

The material web **3** is guided from a processing station for the material web, arranged upstream of the winder **1**, to a turn roll **39'** and from the roll **39'** vertically upward to a contact pressure drum **19'**. The drum **19'** forms a winding nip against a wound reel **47** located in the winding start position. The previously finished wound reel **31** (with spool **29**) is being simultaneously removed from the winder in FIG. **5**. The contact pressure drum **19'** in FIG. **5** is formed by a contact pressure roll which has a relatively small diameter relative to the reel **43**. The diameter is distinctly smaller than the outer diameter of the contact pressure drum **19** illustrated in FIGS. **1** to **4**. The weight of the contact pressure drum **19'** is preferably also lower than that of the drum **19**.

A displacement device **70** arranged on the guide carriage **20** has a guide frame **72** that is fastened to the guide carriage **20** and guides a vertical movable carriage **74** in the directions shown by a double arrow **76**. The contact pressure drum **19'** is rotatably held on the carriage **74** and is driven by a center drive (not illustrated), which is preferably arranged in a fixed location on the vertical carriage **74**. Vertically downward motion of the vertical carriage **74** reduces the distance between the contact pressure drum **19'** and the turn roll **39'** that is supported stationary on the guide frame **72**, as explained below. The vertical displacement travel of the contact pressure drum **19'** is preferably relatively small, particularly one to two times the diameter of the contact pressure drum **19'**.

The operation of the winder **1** in FIGS. **5** and **6** is described below with reference to a spool change. First, an interspace, in which the material web is guided in a free draw, is formed between the contact pressure drum **19'** and a wound reel held by the secondary bearing **27**. For this, the transport device **5** is moved to the right, into the position illustrated in FIG. **5**. The contact pressure drum **19'** is then displaced downward by lowering the vertical carriage **74**, so that during the introduction of an empty spool **43** into the winding start position, the spool can be offset in the primary bearing **17** without deflecting the material web **3**, which is being guided in a free draw from the contact pressure drum **19'** to the almost finished wound reel **31** held by the secondary bearing **27**, as seen in FIG. **6**. This permits the empty spool **43** to be transferred to the primary bearing **17** during the running winding process, without the empty spool previously having been set rotating. This is a result of the spool **43** not coming into contact with the running material web. Only briefly and before a spool change, the new spool is accelerated to the web speed by the primary drive **33**. The contact pressure drum **19'** is then displaced vertically upward. This lays the material web **3** against a circumferential region of the empty spool **43** and the web is guided over the spool. A nip is then formed between the contact pressure drum **19'** and the empty spool **43** by

horizontal displacement of the contact pressure drum **19'**. The material web **3** is severed and its free end is wound onto the empty spool. During the winding start process (FIG. **5**), the completed wound reel **31** is braked and then removed. The transport device **5** then moves to the left in FIG. **5** and transfers the wound new spool **43/47** to the secondary bearing **27**. This condition corresponds to that in FIG. **3**.

In a further embodiment, not illustrated, the nip or winding nip between the contact pressure drum **19'** and the empty spool is already to be formed during the vertical displacement of the contact pressure drum **19'**.

Using the vertically displaceable contact pressure drum **19'** avoids a need for a web throw-on device, which is needed in the winder of FIGS. **1** to **4**. In the winder of FIGS. **5** and **6**, the empty spool is accelerated to the running speed of the material web by the primary drive **33**, which is preferably arranged in a fixed location on the transport device **5**, and the spool is driven by the drive **33** for a specific time, even after the spool change. Only after the wound spool has been transferred into the secondary bearing is the secondary drive **32** activated and the primary drive **33** detached.

The empty spool **43** can be lowered from the ready position down to the winding level and be accelerated to the web speed only at the ready position. As a result, only two drives, which are preferably center drives, are needed for the spool, in order to apply a drive and/or braking torque to the spool during the entire winding process. Since the center drive for the empty spool need not be moved vertically but is moved only horizontally, in a preferred embodiment, only one of the two center drives is assigned to a spool during the entire winding process, which improves the winding quality. Therefore, the primary drive **33** and the secondary drive **32** must be displaceable horizontally, independently of each other and of the transport device **5**.

The vertical mobility of the contact pressure drum **19'** makes it also possible to dispense with a hold-down device, known per se, which deflects the material web guided in a free draw. This enables the empty spool to be moved into the primary bearing without first having to be accelerated to web running speed.

FIG. **6** shows that the secondary bearing **27** includes a reel support **78**, which supports the outside of the wound reel held by the secondary bearing **27** over a circumferential region, and relieves the bearing of load, so that the wound reel does not sag or its sag is only slight. The reel support **78** is arranged underneath the secondary bearing **27** and may for example, have two turn rolls and at least one circulating belt that is guided over them. The structure' of the reel support **78** is a matter of choice and other designs of the reel support are possible. Supporting the wound reel while it is located in the final winding position improves the winding quality.

Common to all of the embodiments of FIGS. **1** to **6** is that the pinch roll **41** can be pressed against the circumference of the wound reel guided by the secondary bearing not only during a spool change, but also during the entire time in which the spool and, respectively, the wound reel wound thereon, is guided and held by the secondary bearing. Winding quality can be thereby improved.

In a preferred embodiment, the contact pressure drum **19** has measuring sensors **67** for the bearing forces at its bearing points. The contact pressure, with which the contact pressure drum **19** is pressed against the circumference of an empty spool **29** or **43** and subsequently against the wound reel **31** or **47** wound thereon, is controlled as a function of the

measured signals from the measuring sensors by a control or regulating device **68**.

Because the primary bearing is in a fixed location on the transport device, the structure of the winder can be simplified with respect to the known winders. In addition, the winder can be reliably controlled/regulated with a relatively low cost outlay.

Although the present invention has been described in relation to particular embodiments thereof, many other variations and modifications and other uses will become apparent to those skilled in the art. It is preferred, therefore, that the present invention be limited not by the specific disclosure herein, but only by the appended claims.

What is claimed is:

1. A winder for the continuous winding of a web of material for forming a wound reel on a spool, the winder comprising:
   - a primary bearing for supporting a spool on which a web is to be wounds the primary bearing being moveable;
   - a secondary bearing, the primary bearing being movable toward and away from the secondary bearing, and the secondary bearing also being adapted to support the spool;
   - a displaceable transport device having a first part on which the primary bearing is supported, the first part of the transport device being displaceable with respect to the secondary bearing, and having a second part which is movably coupled to the first part and which is displaceable with respect to the first part in a direction that is substantially parallel with a direction that the first part is displaceable;
   - a pressure applying device supported on and moveable with the second part of the transport device and positioned so as to engage and form a winding nip with the wound reel when the spool is supported on the primary bearing or on the secondary bearing, the pressure applying device having a circumferential portion over which the web is guided;
   - the primary bearing being arranged in a fixed location on and being moveable along with the first part of the transport device and at a location normally between the pressure applying device and the secondary bearing until the primary bearing is transported by the transport device up to the secondary bearing.

2. The winder of claim **1**, further comprising a controller/regulator connected with the pressure applying device for influencing the line force in the winding nip.

3. The winder of claim **1**, further comprising a thrust device for displacing the displaceable transport device toward and from the secondary bearing.

4. The winder of claim **1**, wherein the pressure applying device comprises a contact pressure drum.

5. The winder of claim **4**, further comprising a displacement device supporting the contact pressure drum for being moveable substantially vertically across the direction of displacement of the transport device.

6. The winder of claim **5**, wherein the displacement device is arranged on a guide carriage for the contact pressure drum.

7. The winder of claim **1**, further comprising a primary drive connected with the primary bearing for rotating the wound reel at the primary bearing.

8. The winder of claim **7**, wherein the primary drive is a center drive for the center of the wound reel at the secondary bearing.

9. The winder of claim **7**, wherein the primary drive is at a fixed location on and therefore moves with the transport device.

10. The winder of claim **7** further comprising a secondary drive connected with the secondary bearing for rotating the wound reel at the secondary bearing.

11. The winder of claim **10**, wherein the secondary drive is a center drive for the center of the wound reel at the secondary bearing.

12. The winder of claim **1**, further comprising a first guide for the transport device along which the first part of the transport device moves relative to the secondary bearing.

13. The winder of claim **12**, wherein the first guide comprises a guide rail extending toward the secondary bearing on which the transport device is displaceable.

14. The winder of claim **13**, wherein the guide rail is at least substantially horizontal.

15. The winder of claim **12**, wherein the second part of the transport device comprises a guide carriage supported on the first part of the transport device;
   - the pressure applying device being supported on the guide carriage;
   - and the pressure applying device being moveable with respect to the first part of the transport device on the guide carriage.

16. The winder of claim **15**, further comprising a second guide for supporting the guide carriage.

17. The winder of clam **16**, wherein the second guide comprises a rail disposed on the first part of the transport device and extending toward the secondary bearing.

18. The winder of claim **1**, wherein the pressure applying device is moveable with respect to the transport device on which the pressure applying device is supported to maintain the winding nip as the diameter of the wound reel changes.

19. The winder of claim **18**, wherein the pressure applying device is moveable along the transport device with a maximum stroke of less than half the material layer of thickness of a finished wound reel.

20. The winder of claim **19**, wherein the pressure applying device comprises a hydraulic-piston/cylinder unit with a piston having a maximum stroke of less than half the material layer of thickness of a finished wound reel.

21. The winder of claim **17**, wherein the first guide also comprises a guide rail extending toward the secondary bearing on which the transport device is displaceable.

22. The winder of claim **21**, wherein the guide rail of the first guide is substantially parallel to the guide rail of the second guide for the guide carriage of the pressure applying device.

23. The winder of claim **16**, wherein the pressure applying device is moveable exclusively along the first and second guides and essentially horizontally.

24. The winder of claim **1**, wherein the pressure applying device comprises a rotatable contact pressure drum and the winder further comprises a drive for driving the contact pressure drum to rotate.

25. The winder of claim **1**, further comprising a pinch roll moveable against the outer surface of the wound reel at the location of the secondary bearing.

26. A method for winding a continuous material web onto a spool to form a wound reel, the method comprising the following steps:
   - guiding the material web over a partial circumferential region of a pressure applying device, holding the pressure applying device against the wound reel and guiding the material web through a winding nip formed between the pressure applying device and the wound reel;
   - moving the pressure applying device with respect to the wound reel to form a free draw of the material web

between the circumferential region of the pressure applying device and the almost finished wound reel;

introducing an empty spool into the region of the free draw in a winding start position;

moving the pressure applying device to form a new winding nip between the pressure applying device and the empty spool;

severing the material web at a location before the wound reel;

winding the free end of the material onto the empty spool to form a new wound reel;

controlling/regulating the line force in the winding nip and thereby compensating for increasing wound reel diameter by displacing the pressure applying device with reference to the new wound reel;

transferring, using a single common transport device that carries the pressure applying device and the new wound reel, the new wound reel together with the pressure applying device that forms the new winding nip into a final winding position while the winding process proceeds; and

finishing the winding of the new wound reel with continued control/regulation of the line force in the winding nip.

27. The method of claim 25, wherein the pressure applying device is displaced in relation to the transport device carrying the pressure applying device for compensating for the increasing wound reel diameter.

28. The method of claim 27, further comprising compensating for the increased wound reel diameter by also displacing the transport device.

29. The method of claim 26, further comprising forming a second winding nip between the wound reel and a separate pinch roll which presses on the wound reel at least while the material web is being guided in the free draw.

30. The method of claim 26, further comprising moving the empty spool into the winding start position sufficiently to deflect the material web which is being guided in the free draw, so that the web is guided over a circumferential region of the empty spool.

31. The method of claim 26, wherein the empty spool is introduced from above before being introduced into the winding start position;

and further comprising the step of lowering the pressure applying device below the position of introduction of the empty spool from above to an extent that the material web is guided in a free draw from the pressure applying device to the almost finished wound reel when the empty spool has assumed the winding start position.

32. The method of claim 31, further comprising the step of after the empty spool has assumed the winding start position, raising the position of the pressure applying device to wrap the material web partially circumferentially around the spool in the winding start position.

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